Recycling & Solid Waste
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Fly Ash In Transportation

What Is Fly Ash?

Fly ash is a by-product of power plants that burn pulverized coal. The types and amounts of ash that a plant furnace produces depend on the type of coal burned, the type of furnace used and the manner in which the ash is collected. For example, "dry bottom ash" is the residue of coal burned in dry bottom boilers, "wet bottom boiler slag" is the residue of a wet-bottom boiler that is emptied into a hopper filled with water and "fly ash" is the material obtained from the dust-collection system which removes particulates from the exhaust gases. Typically, particle size of fly ash is within a range of 0.005 mm to 0.074 mm. There are two classifications of fly ash. Class F fly ash is produced by burning bituminous or anthracite coal. Class C fly ash is a by-product of burning lignite or subbituminous coal.

What's The Problem?

The United States produces over 60 million tons of coal fly ash every year. In North Carolina, there are over 20 plants that produce a total of about three million tons of fly ash every year. For utility companies that produce fly ash essentially as a waste product, the primary problem is the disposal and management of this waste. Although fly ash can be used in construction, the demand of which can never keep pace with the high rate of production, the primary difficulty is in transporting the material from a few relatively remote locations of power plants to the construction sites spread throughout a region. Less than 25 per cent of recycled fly ash is reused. Under half of this is used for large volume projects. The excess must be disposed of in land-fills, in waste piles or in sluice ponds.

Uses of Fly Ash In Transportation

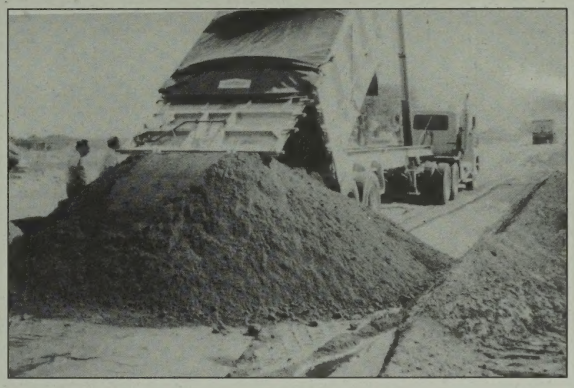
Fly ash has pozzalanic properties. It can be used as a cement replacement and/or as a mineral admixture in portland cement concrete—resulting in economical benefits as well as enhanced performance. For example, in fresh concrete, Class F fly ash improves workability, pumpability and reduces bleeding; Class C fly ash can reduce the time of setting. In hardened concrete, fly ash can reduce permeability and use of Class C fly ash can mitigate potential alkali silica reactivity (ASR) thus improving durability of concrete in pavements as well as in structures.

Fly ash also can be used in conjunction with other mineral admixtures such as silica fume or metakaolin as an enhancer. Research in this area is growing.

As waste disposal, however, the amount of fly ash that can be used as cement replacement and mineral admixture is minuscule. Only bulk uses of fly ash in large quantities in major projects can have any significant effect. Such uses include structural fills, backfills, embankments, subgrade stabilization, pavement base courses and roller compacted concrete. Utility companies and other major producers continually try to put this resource into beneficial use and thereby save on disposal costs as well as create value for the potential users such as highway agencies. [1]

From Waste Product to By-product: Past Applications

In 1982, a quarter-mile stretch of road to connect 38th Street with Rt. 65B in Pine Bluff, Arkansas was constructed. The 1,400 tons of fly ash used in the base course was supplied by Arkansas Power and Light's White Bluff Plant. The Class C fly ash was mixed with water in a hopper at the site to give a moisture content of 14 per cent. The fly ash pavement could be constructed by paving crews using conventional equipment and could be competitive with conventional pavement. Evaluations performed by the EPRI indicated no consolidation or lateral movement in the base course. Falling weight deflectometer test readings indicated no weakness in the base or pavement surface. Visual inspections revealed no unusual cracks or distress elements in the surface. The report describes the pavement performance to be satisfactory. [1]



Shortly after the Beneficial Use for Coal Ash Act was passed into law in 1986, Duquesne Light Company, located outside Pittsburgh, Pa., began turning their waste product into by-products.

In 1987 Duquesne shipped 353,000 tons of coal ash to a structural fill for the East Street Expressway connecting downtown Pittsburgh to I-79. The embankment was 1490 feet long, 210 feet wide and 50 feet deep – the largest utilization of coal by-product at that time. Even though Duquesne donated the fly ash and shipped it to the construction site for no charge, the company saved nearly $700,000 by avoiding disposal cost of the fly ash. [5]

Present and Future Applications In North Carolina

In May 1995, the NCDOT used 4000 cubic yards of Class C fly ash in the embankments of a project in Halifax County. The division overseeing the project was very pleased with the installation of the fly ash. Jimmy Deal, Division Four Resident Engineer, says he "wouldn't hesitate to use it again." North Carolina specifications for fly ash use state that no ash from boilers fired with coal and petroleum coke can be used.

Hauling distance and potential low rate of supply in warmer months are the two main obstacles in the utilization of fly ash in highway construction. In a similar Duplin County project last year, the contractor requested and received permission for the use of fly ash as embankment fill. The generator of fly ash could supply only one or two truck loads per day, not nearly as fast as it was needed at the project. Thus, the contractor withdrew his request to use fly ash. New plans to utilize fly ash on a different part of the project this year are being studied.

Investigation of the use of fly ash as an admixture to mitigate potential ASR is a part of a current NCDOT contract research project.

The NCDOT is committed to recycle and utilize environmentally acceptable solid waste products in general and fly ash in particular. The department is continually on the look out for upcoming projects where such materials can be used.

Standards

AASHTO M295-94, "Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete," AASHTO *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, Part I, 1995.

ASTM C 618-92b, "Methods of Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete."

NCDOT *Standard Specifications for Roads and Structures*, Section 1000-4(I) "Portland Cement Concrete for Structures and Incidental Construction - Use of Fly Ash," 1995.

NCDOT *Standard Specifications for Roads and Structures*, Section 1024-5 "Materials for Portland Cement Concrete - Fly Ash," 1995.

Publications

1. DiGioia, A.M., Brendel, G.F. *Fly Ash Design Manual for Road and Site Applications*, Vols. 1 and 2., Prepared for Electric Power Research Institute by GAI Consultants Research Project 2422-2. TR - 100472, Final Report. April 1992.

2. Ensley, Curtis L., Hanks, David L. *Effectiveness of Fly Ash in Reducing Expansions Due to Alkali-Silica Reaction*, Technical Report CE-S 9502, Department of Civil Engineering, University of North Carolina at Charlotte. July 1995.

3. Halstead, Woodrow J. *Use of Fly Ash in Concrete*, NCHRP Synthesis #127. Transportation Research Board. October, 1986.

4. Moulton, L.K., Seals, R.K. and Anderson, D.A. *Utilization of Ash from Coal-Burning Power Plants in Highway Construction*, Highway Research Record, n. 430, pp. 26-39, 1973.

5. Tarricone, P. "Fly Ash for Hire," *Civil Engineering*, v. 61, n. 10, pp. 46-49. American Society of Civil Engineers. 1991.

The purpose of the Information Bulletin is to provide NCDOT staff and others with the latest information on the use of recycled products and non-hazardous solid waste materials in transportation. Where appropriate, permission has been received from other agencies to reprint information contained in this bulletin.

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